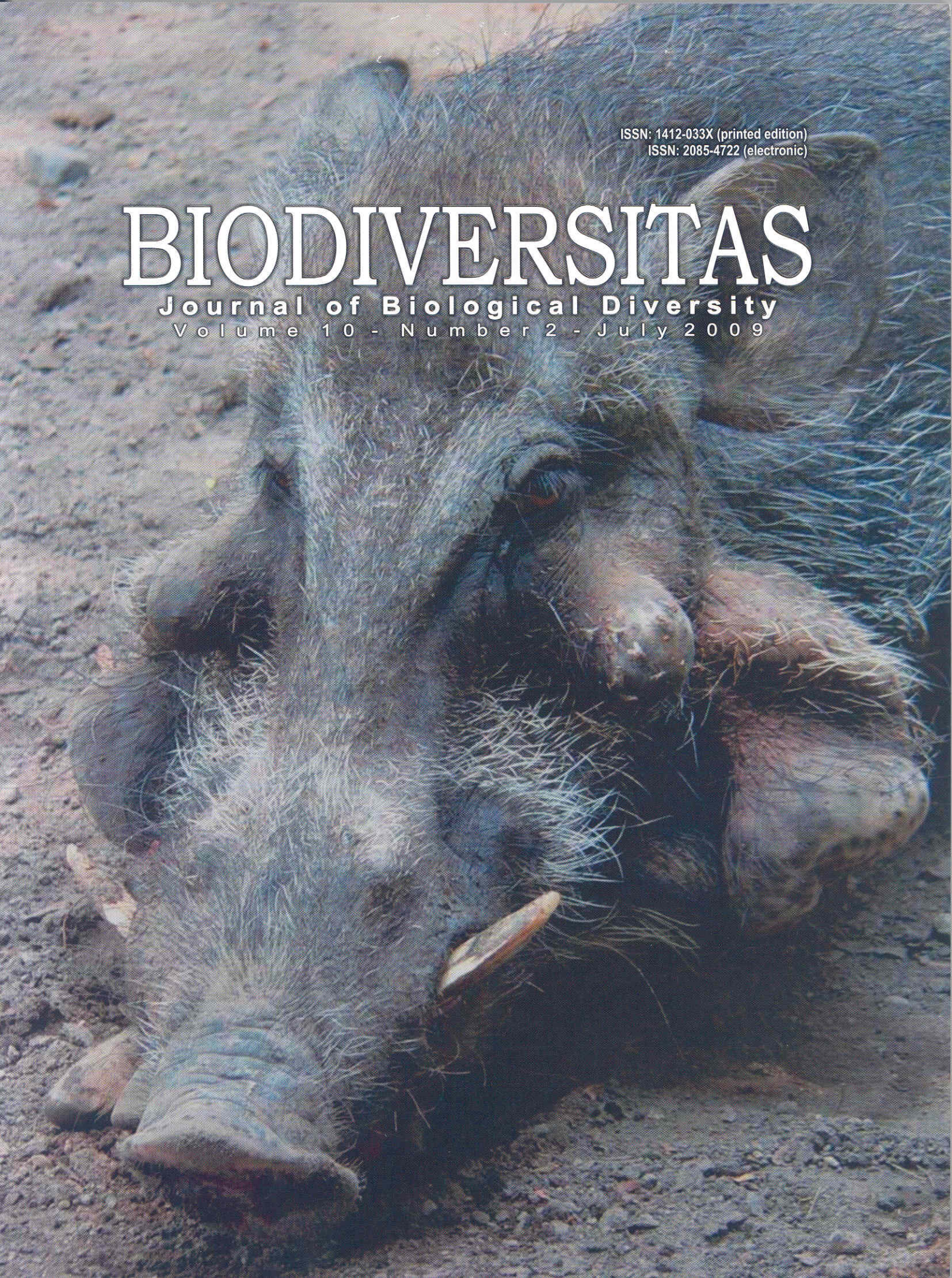
ISSN: 1412-033X (printed edition)
ISSN: 2085-4722 (electronic)

BIODIVERSITAS

Journal of Biological Diversity

Volume 10 - Number 2 - July 2009



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BIODIVERSITAS

Journal of Biological Diversity

Volume 10, Number 3, July 2009

FIRST PUBLISHED:
2000

ISSN:
1412-033X (printed edition)
2085-4722 (electronic)

PUBLISHER:
Biology Department, Faculty of Mathematics and Natural Sciences, Sebelas Maret University Surakarta and Society for Indonesian Biodiversity

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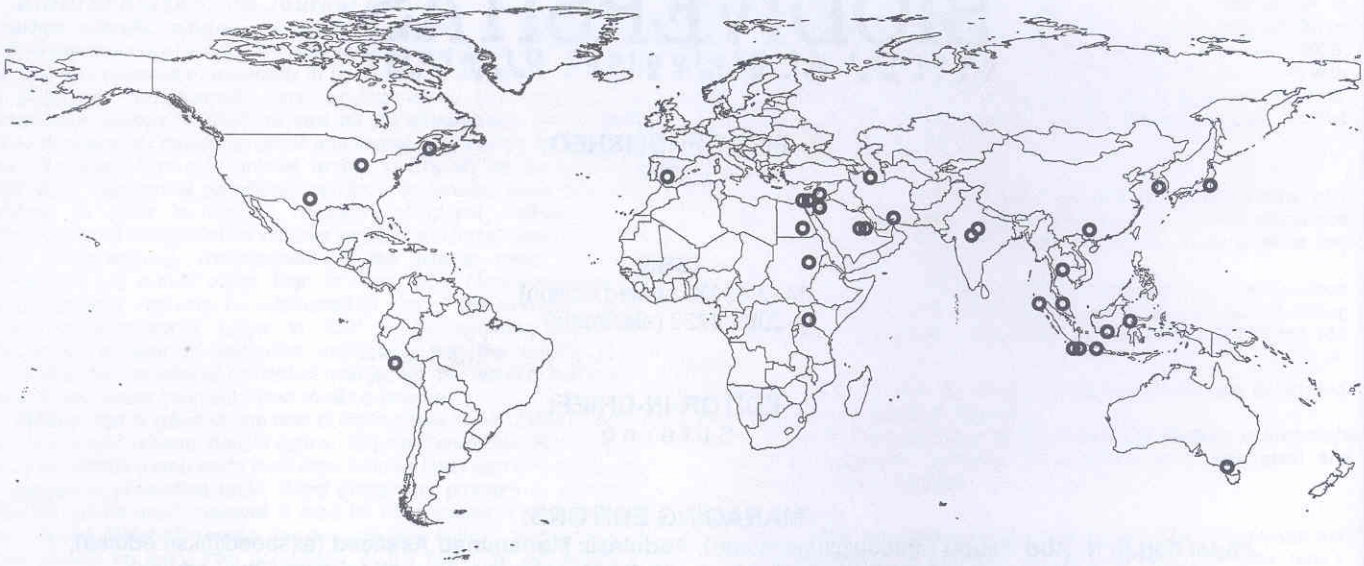

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BIODIVERSITAS
Volume 10, Number 3, July 2009
Pages: 120-123

ISSN: 1412-033X (printed edition)
ISSN: 2085-4722 (electronic)

Correlations Between Degree of Petal Fusion, Leaf Size and Fruit Size: A Case in *Syzygium* (Myrtaceae)

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Received: 10th May 2009. Accepted: 26th June 2009.

ABSTRACT

Syzygium is one of large genera of the flowering plants. In order to simplify the identification, a classification is required, e.g. based on degree of petal fusion, leaf size and fruit size. Due to variations of vegetative and generative characters, a correlation analysis was carried out. The aim of this research is to know the correlation between degree of petal fusion, leaf length and fruit diameter. The result of this research showed that there is positive correlation between those three variables. The increase of leaf size will increase fruit size and petal lobe depth.

Key words: *Syzygium*, petal fusion, free, intermediate, fused petal, leaf, fruit size.

INTRODUCTION

Syzygium is a large genus of flowering plant which consists of over ca 1,040 species (Govaerts et al. 2008), or about 1,200 species (Parnell et al., 2007), widely distributed in the tropics and subtropics of the old world from Africa, mainland Asia, Malesia, Australia, New Zealand and the western Pacific (Biffin, 2005). This genus is one of the largest and most taxonomically difficult genera in the Myrtaceae and there is a considerable dispute as to whether it is possible to split it into sections or even whether it should be recognized as a separate genus (Parnell and Chantaranothai, 2002). Due to large number of species, >1000 species (Frodin, 2004), it should be grouped to simplify and ease for recognition. There has been a lot of ways of grouping e.g. based on the succulency of fruits, leaf shape, number of pairs of lateral veins etc. (Chaffey, 1999), geographical Old World and New World (Schmid, 1980).

In *Syzygium*, the generic concepts of Merrill & Perry were adopted by the majority taxonomists (Craven et al., 2006). The generic concepts have been based upon relatively fine levels of morphological distinction (Craven, 2001). In this concept, *Syzygium* includes the species with and without an intercotyledonary inclusion, either inflorescence solitary or in cluster, on old trunk, axillary, or terminal, calyx either calyptrate or free.

Ashton (2006) accepts the separation of *Syzygium* Gaertn. from *Eugenia* L., and the inclusion of *Cleistocalyx* Blume, now substantiated on both morphological and molecular grounds (Schmid 1972; Harrington and Gadek, 2004; Wilson et al., 2005; Biffin et al., 2006; Craven et al., 2006).

Different plant characters may show varying degrees of form diversification or conservatism across phylogenetically related taxa (Herrera, 2004). The present study uses data from a recent systematic study of Sumatran *Syzygium* to investigate diversity in reproductive and vegetative plant parts. Previous study that had been done include: correlation between the resource status of a flower or individual and the proportion of reproductive resources allocated to female function in *Clarkia unguiculata* (Mazer and Dawson, 2000), correlation of the proportion of male relative to bisexual flowers in *Leptospermum myrsinoides* and *L. continentale* (Myrtaceae) increases among upper and outer branch positions (O'Brien, 1994; Spalik and Woodell, 1994). Correlation between plant age and proportion of plant gender e.g. in *Arisaema triphyllum*, younger plants are more likely to be male than female (Policansky, 1981).

In this paper, *Syzygium* is grouped based on the degree of petals fusion. In general, there are two groups of *Syzygium* namely (i) species with free petals (the petals spread open at anthesis), (ii) species with coherent petals (the petals are free from each other but they closely cohere and at anthesis fall as a cap). This is sometimes described as a calyptra but it is not

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the same as the true calyptras found in Myrtaceae in which the calyx lobes are fused to each other and the component lobes are no longer able to be seen. However, there are a few species that may be intermediate. In general this is a good way of separating the genus into smaller groups. Craven (*pers. comm.,* 2007) stated that although it is an artificial grouping but it can be conducted because of the very large number of species.

Although section *Jambosa* (free petalled *Syzygium*) tends to have larger pollens with a proportionally larger apocolpium than section *Syzygium* (coherent petalled *Syzygium*), it does not appear possible to distinguish the species of *Syzygium* on the basis of features of pollen visible under SEM (Parnell, 2003). Thus In some cases, the degree of petal fusion may be important. Another reason why choosing petal fusion for the dividing character is that this character makes the division balanced. The use of other characters such as the present of hairs, leaf form, flower bud shape, fruit size, etc. may cause unbalanced divisions namely very large versus small division. This can be interpreted that the small division may be only an exception or deviation.

Although scientific achievement has been gained in terms of *Syzygium*, we have not been able to be ready to anticipate the loss of this genus due to aspects related to environment such as the loss of habitats and ecosystems. Although the development of our understanding on *Syzygium* grows exponentially, the understanding on the biodiversity of these species is still not enough to plan the future of *Syzygium*. Therefore, a study into the selection of characters is needed.

In practice, there are some problems concerning the variation of petal fusion namely most (66%) of about 2500 specimens of *Syzygium* at Herbarium Bogoriense are without flowers and or fruits. Difficulties faced in key writing, due to the large number of sterile specimens. The present study examines variations within plants and correlation between the degree of petal fusion with leaf and fruit size. This allows us to seek preliminary evidence for identifying sets of integrated characteristics. Studying part of covariation and phenotypic correlations in phylogenetically related taxa may increase our understanding of plant evolution.

MATERIALS AND METHODS

Herbarium specimens of *Syzygium* from Sumatra in the Herbarium Bogoriense (BO), fresh specimens from Bogor Botanical Garden (KRB), and some fresh specimens directly collected from North and West Sumatra were examined. The specimens included 30 described taxa sampled randomly to include the specimens with free petals, free and coherent petals all together at the same specimens (intermediate), and coherent petals. Variables used were the degree of petal fusion, maximum leaf length and the maximum fruit diameter. The degree of petal fusion was scored as coherent (i), intermediate (ii), and free petalled (iii). Organ size covariation and phenotypic correlations were studied among *Syzygium* species. Scale relationships were investigated by regression analysis.

RESULTS AND DISCUSSION

Generally, the leaf length and fruit diameter correlated positively and significantly. The leaf length also correlated positively with the degree of petal fusion and similarly the fruit diameter (Figure 1). Taxonomic studies can be useful to establish major phenotypic correlations in *Syzygium*. Sometimes it is difficult to determine whether the plants are free or coherent petalled due to the absence of the flowers. However, it can be solved by comparing them with the other materials from the other islands, or by predicting using correlation.

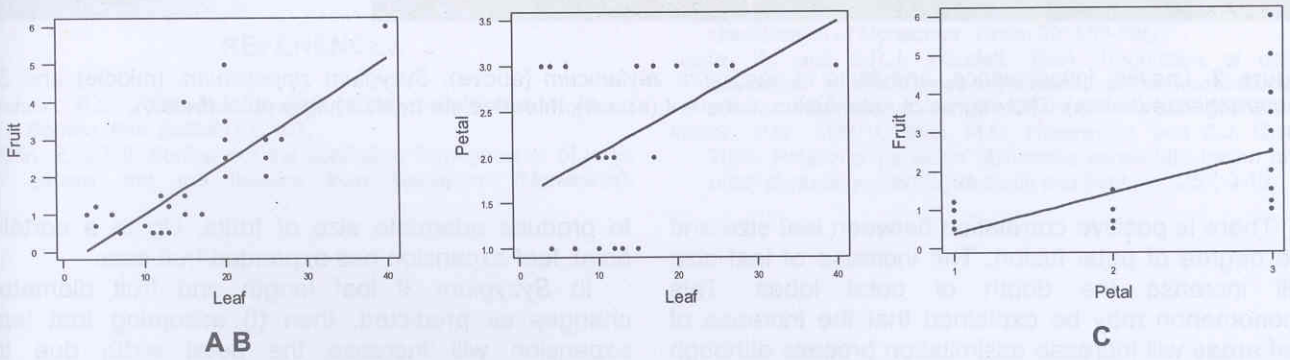

Figure 1. Positive correlation between leaf length and petal fusion degree, regression: y = 1.55 + 0.0484 x, r = 0.213 (A); positive correlation between leaf length and fruit horizontal diameter, regression: y = - 0.378 + 0.138 x, r = 0.583 (B); Positive correlation between petal fusion degree and fruit horizontal diameter, regression: y = - 0.669 + 1.05 x, r = 0.471 (C).

Figure 2. Leaves, inflorescence, and fruits of *Syzygium zeylanicum* (above), *Syzygium zippelianum*, (middle) and *S. samarangense* (below). The degree of petal fusion: coherent (above), intermediate (middle), free petal (below).

There is positive correlation between leaf size and the degree of petal fusion. The increase of leaf size will increase the depth of petal lobes. This phenomenon may be explained that the increase of leaf areas will increase assimilation process although lack of sun light and the petals will developed and broken into deep lobes. The leaf size correlated positively with fruit size, which means that equilibrium between leaves and fruits should be reached in order to produce adequate size of fruits. Up to a certain point, leaf expansion has expanded fruit size.

In *Syzygium*, if leaf length and fruit diameter changes as predicted, then (i) assuming that leaf expansion will increase the petal width due to consequences that some amount of the leaf product will be stored in the petals. (ii) assuming that the increase of petal width will increase the degree of petal fusion or petal tendency to be free because the